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Arsenic Vendor Forum
Albuquerque, NM

Effects of Water Quality Variation on Arsenic Removal

Joon H. Min, Christian Tasser, Amily Zhang, Lina Boubs, Gil Crozes, Robert Cushing and Janet G. Hering*

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Introduction

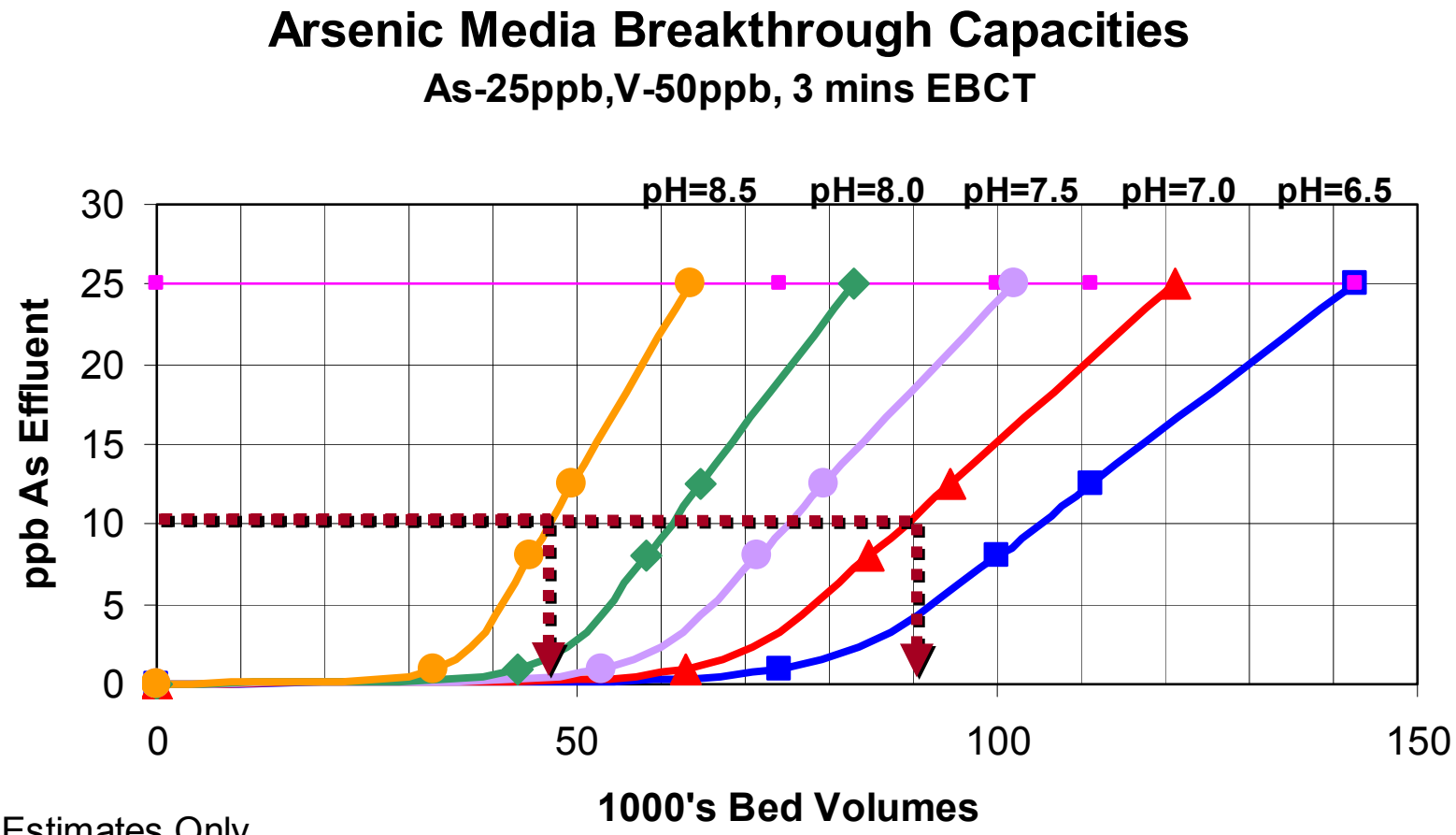
Project Background

- Arsenic compliance
- Implementation under progress
- Multiple treatment options
- Separation vs. accumulation approach
- Impact of water quality variations on arsenic removal

Focus on Single-Use Media Adsorption

- Simple operation (minimum staffing required)
- Implementation is straightforward
- Limited liquid waste generation on-site
- Typically no chemical requirement (pH control may be needed)
- Water quality may impact performance

Impact of pH on Adsorption Media



Estimates Only

Projection done by Francis Boodoo, Purolite

Objectives of AwwaRF 3101

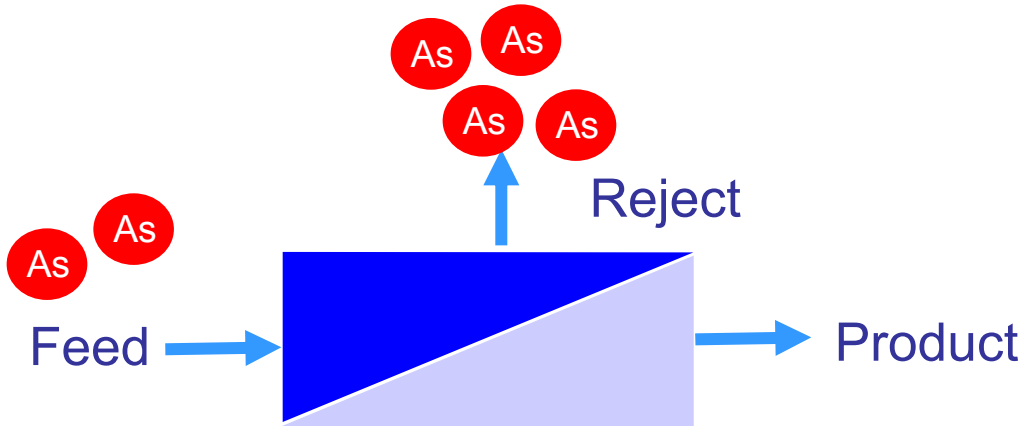
- Identify causes and impacts of water quality (pH) variations
- Conduct challenge tests for adsorptive media
- Develop mitigation strategies for potential impacts

Impacts of Water Quality on Arsenic Removal

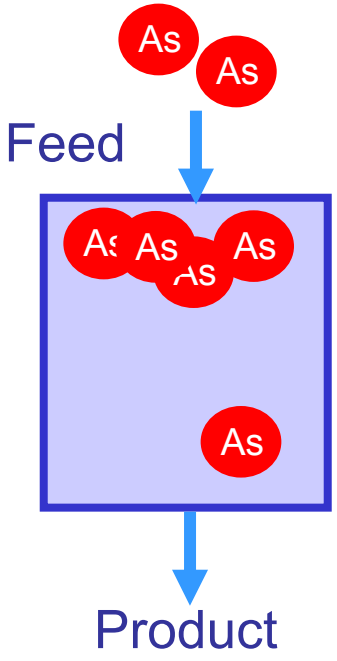
Variations of Water Quality

- pH and competing anions
- Natural fluctuations
- Operational changes (well shutdown)
- Microbial activities (photosynthesis, etc.)
- Blending of two different source waters
- Chemical feed system failure (pH control failure)

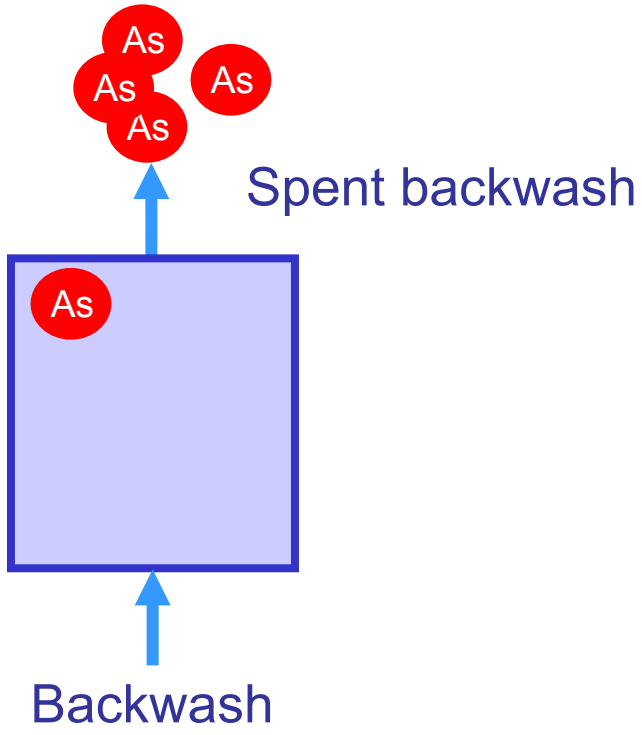
Separation Processes (Continuous)



Separation Processes (Non-Continuous)

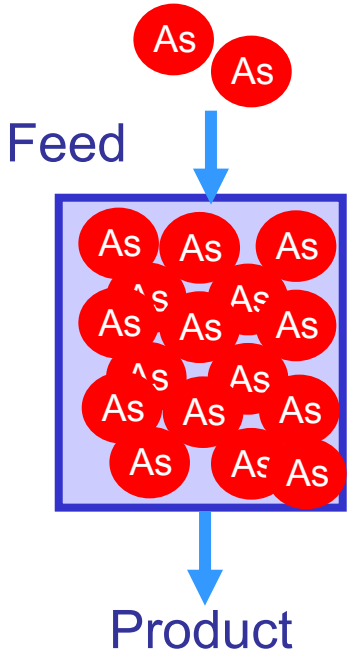


(a) Normal operation

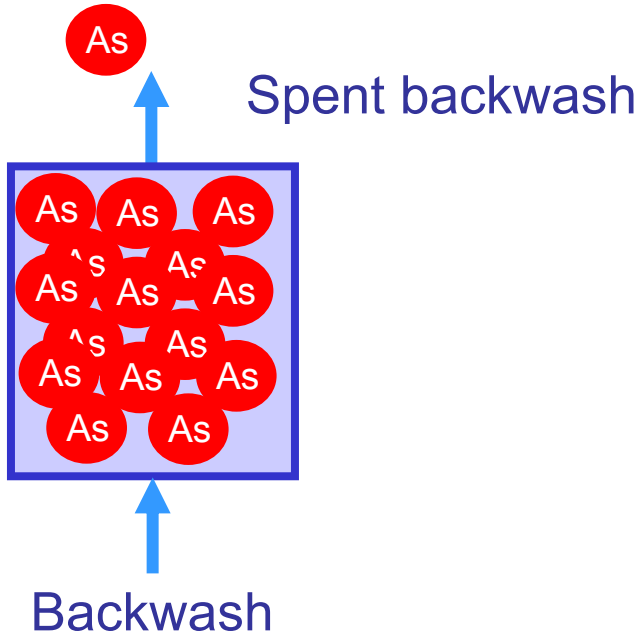


(b) Off-line backwash

Accumulation Processes (Continuous)

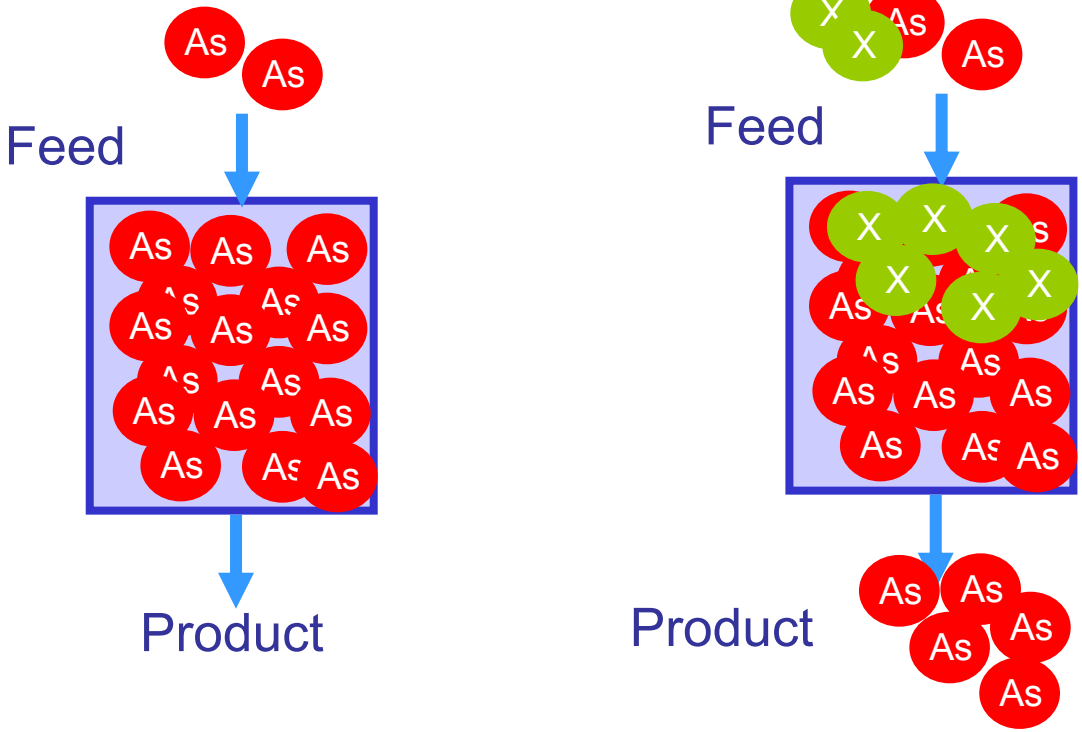


(a) Normal operation



(b) Off-line backwash

Water Quality Effects on Accumulation Processes



(a) Normal operation

(b) Change in water quality

Media Challenge Test Bench Scale

Bench-Scale Testing Conditions

- Total arsenic after spiking: 50 ug/L (as As(V))
- Raw water pH = 8.2, adjusted to pH 7

Parameters	**Conditions**
Columns	8
Length	30 cm
Diameter	1.5 cm
EBCT	2 - 3 minutes
Media height	12 - 17 cm
Flow rates	10 ml/minute

Media Washing

- Fine suspended particles during start-up

Titanium based

Iron based

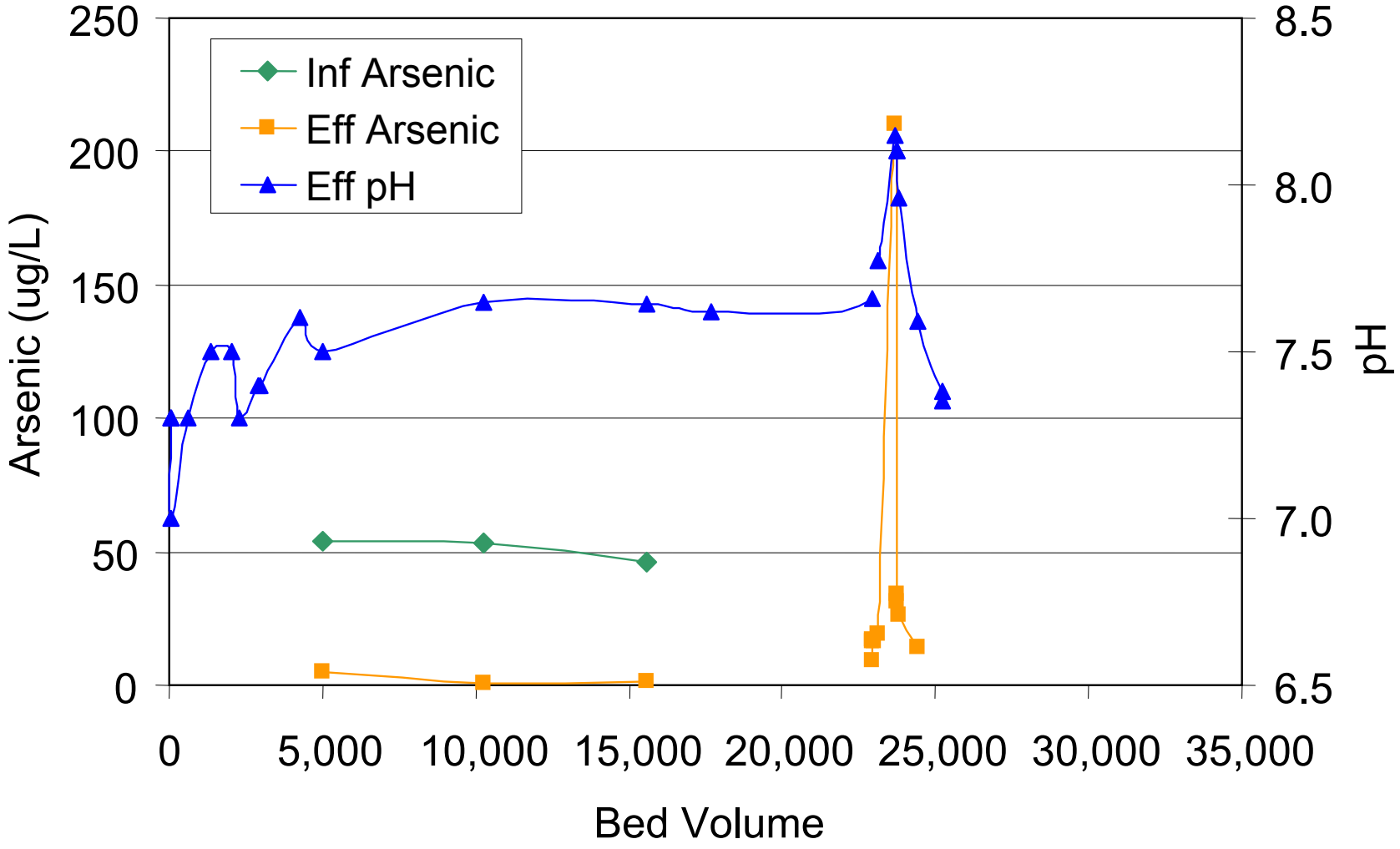
Resin based

Bench Testing (Signal Hill)

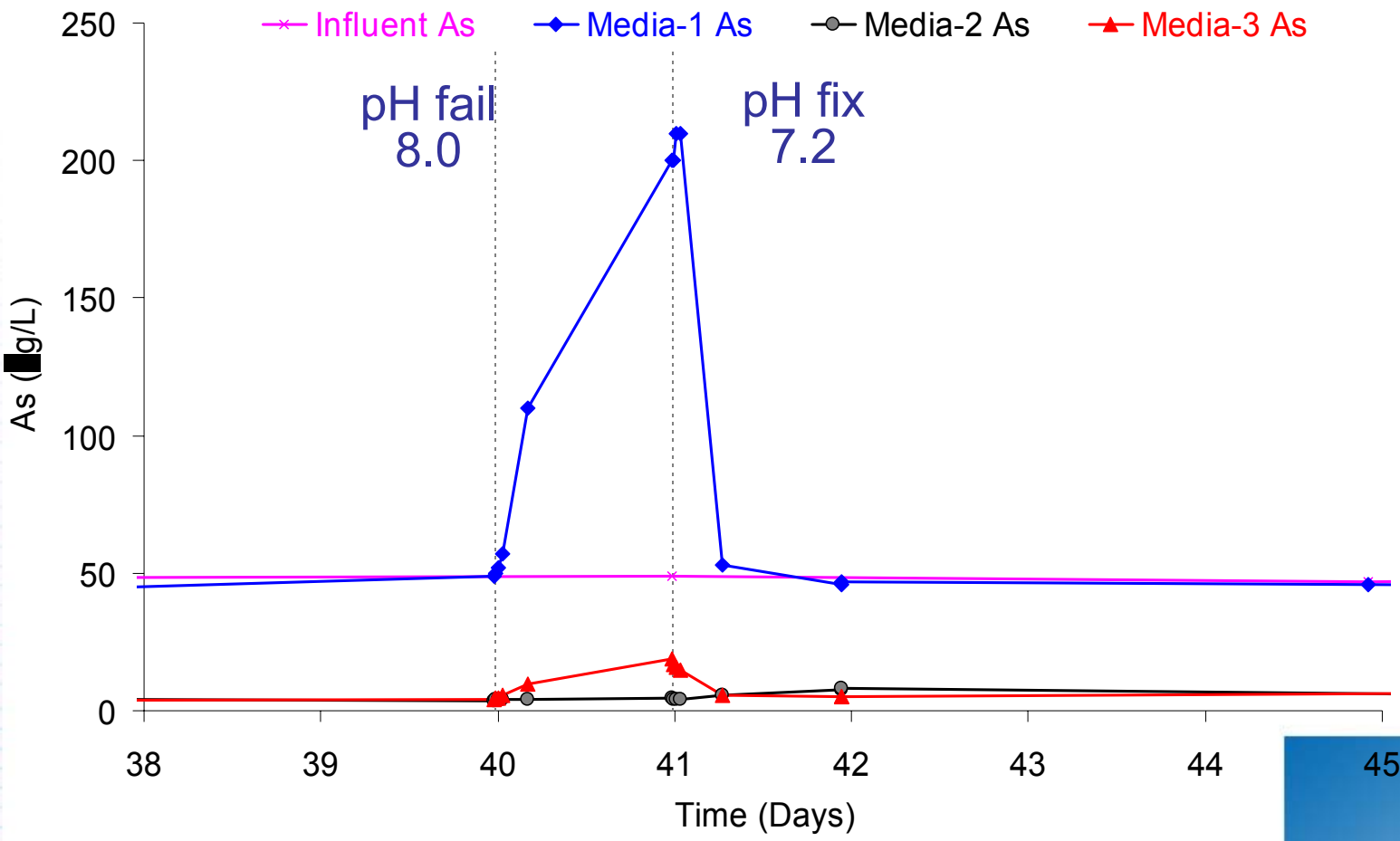
Media Challenge Tests

- pH feed was shut off or chemicals spiked
- Samples were taken after 10 minutes, 30 miutes, 1 hour, 6 hours, 24 hours
- pH was fixed or chemical spike removed
- After the fix, samples were taken at 10 min, 30 minutes, 1 hour, 6 hours, 24 hours

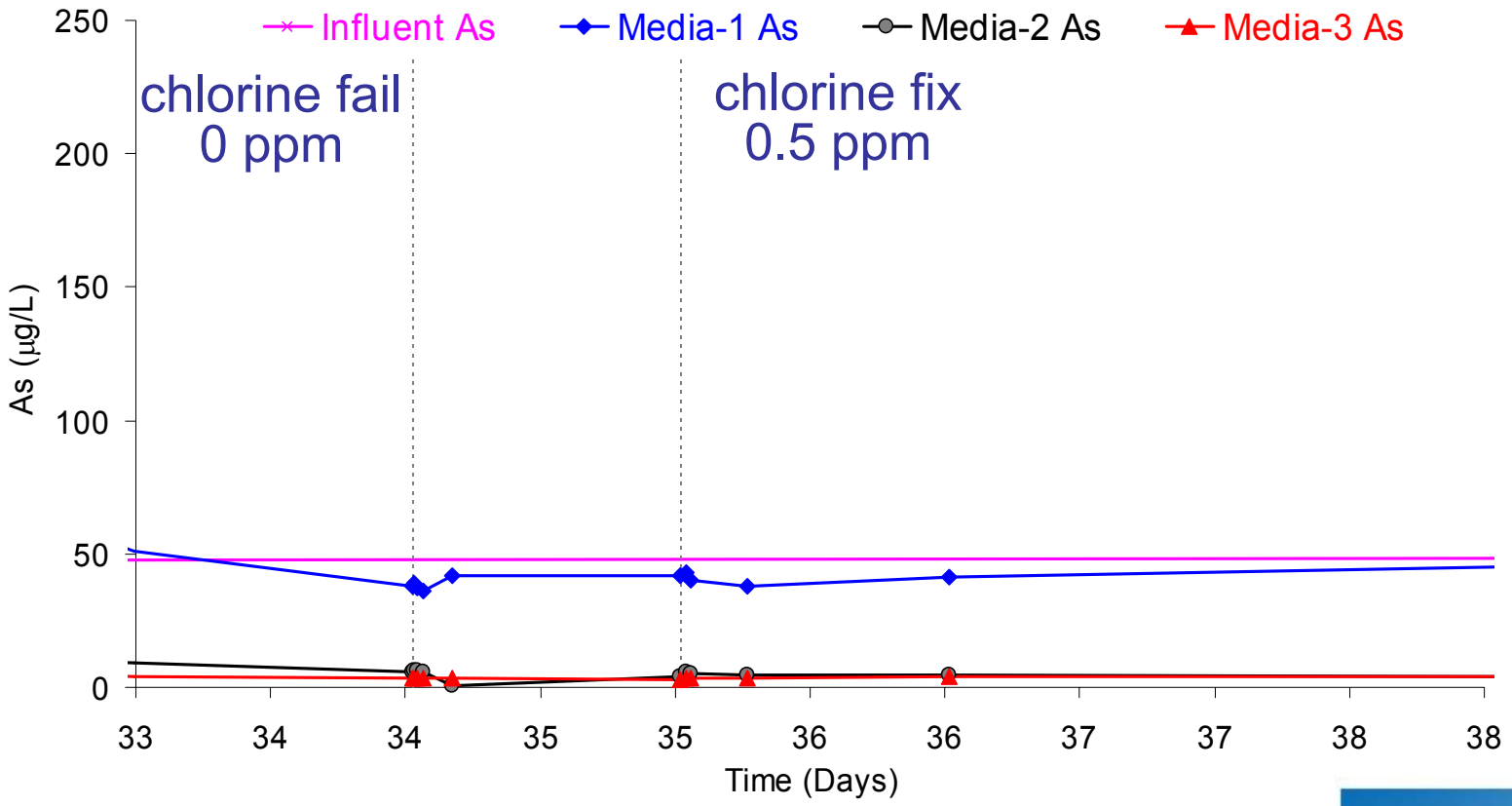
Characteristics of Arsenic Peaking



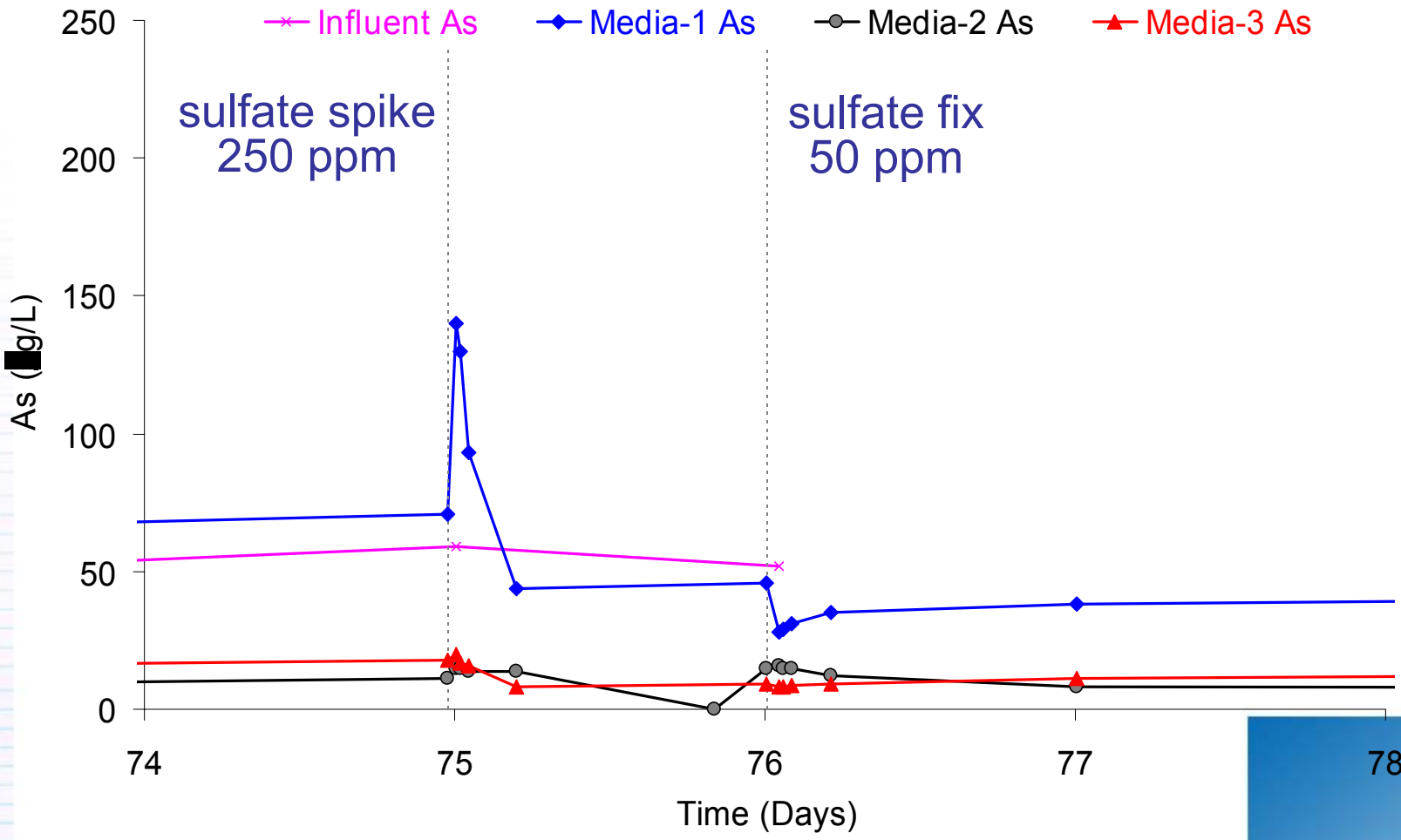
Impact of pH on Effluent Arsenic



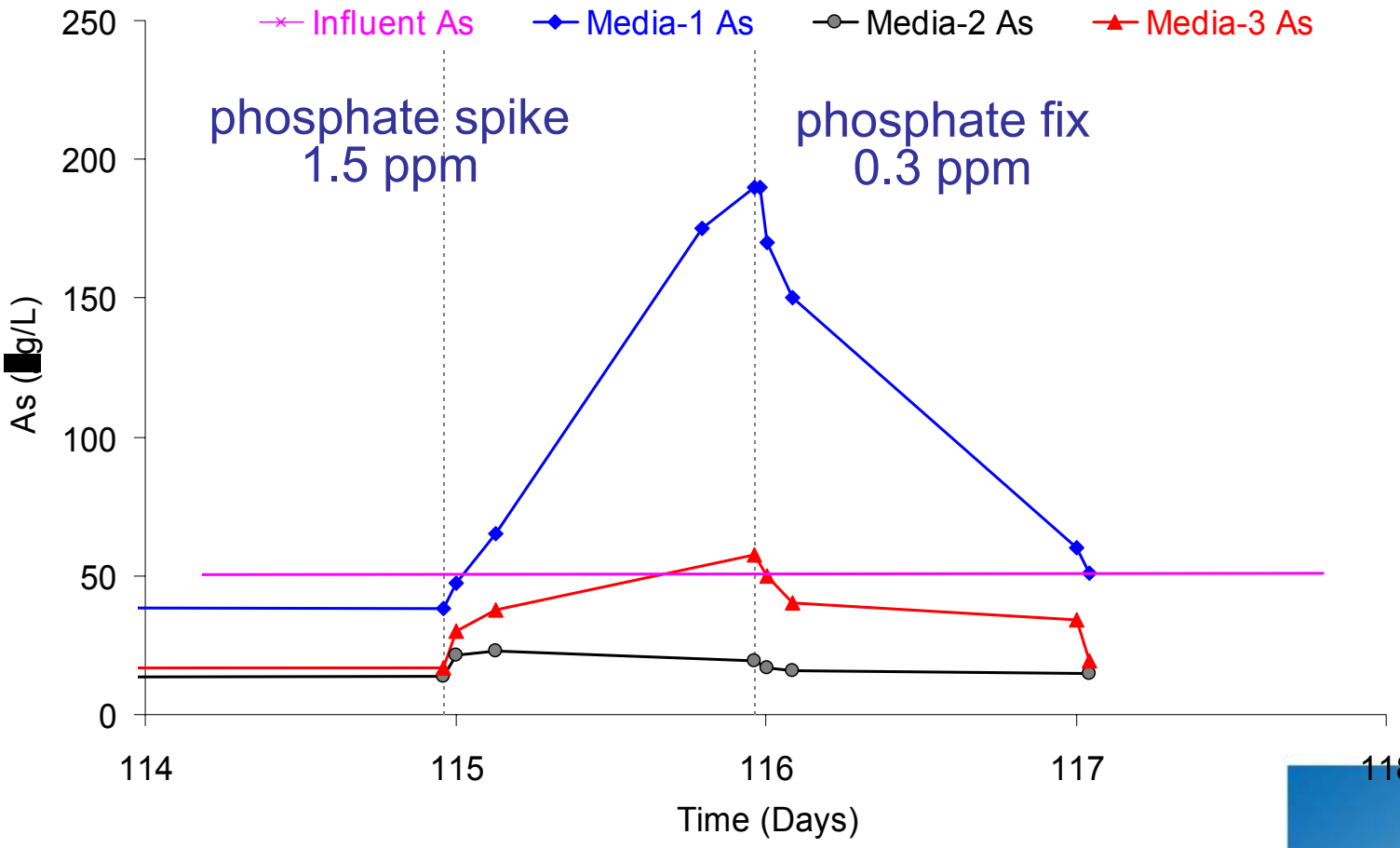
Impact of Chlorine on Effluent Arsenic



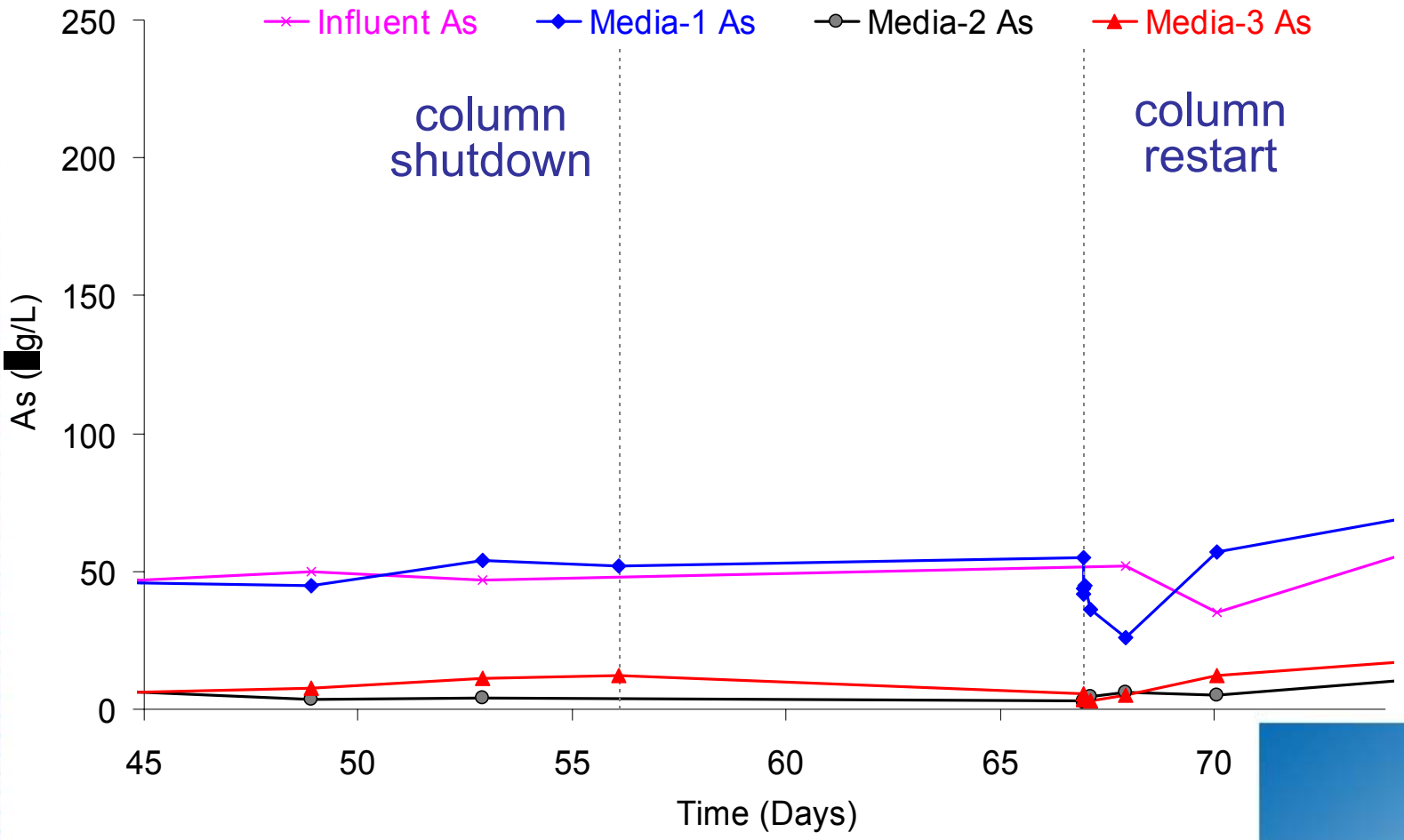
Impact of Sulfate on Effluent Arsenic



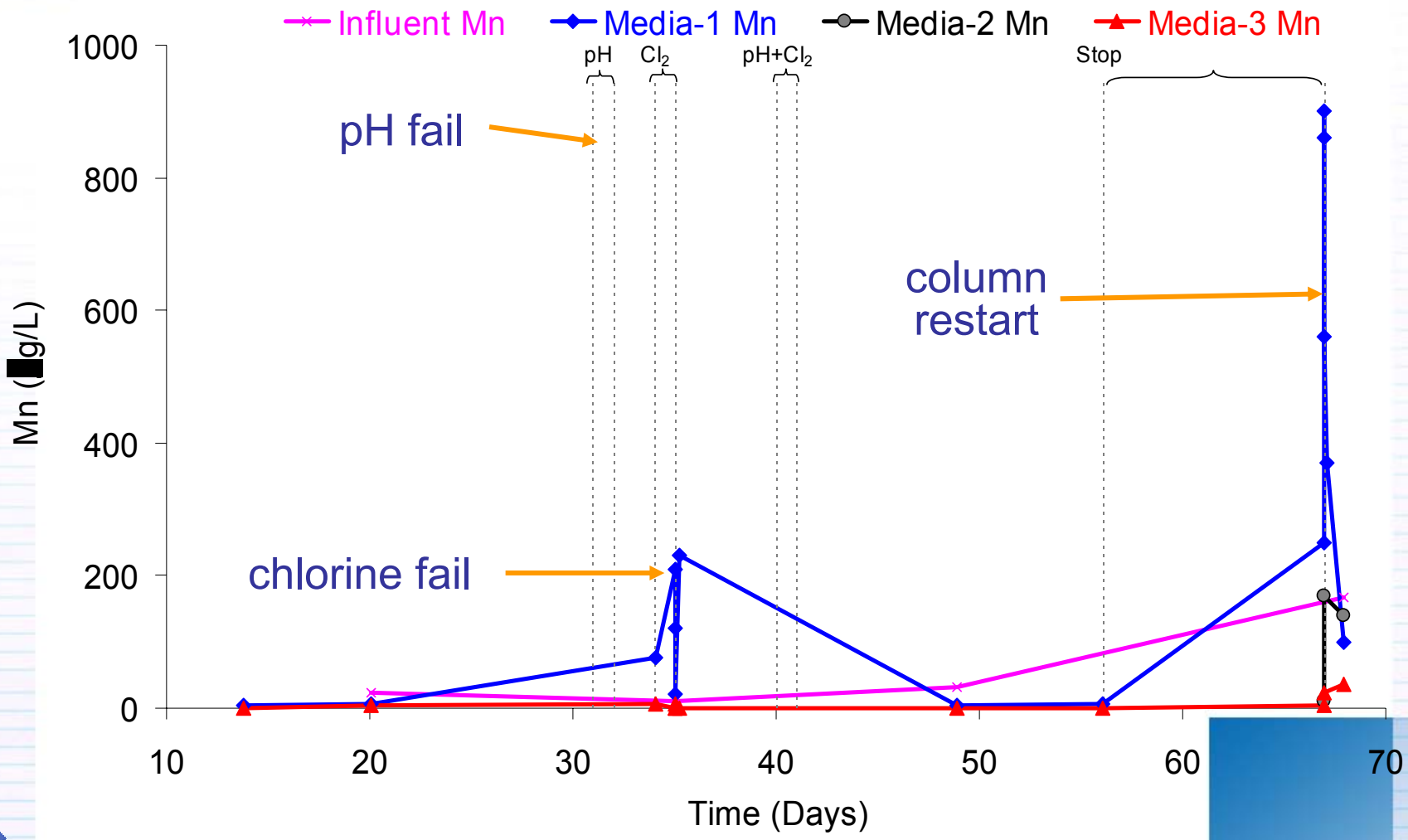
Impact of Phosphate on Effluent Arsenic



Impact of Shut-down on Effluent Arsenic



Impact of Challenge Tests on Effluent Mn



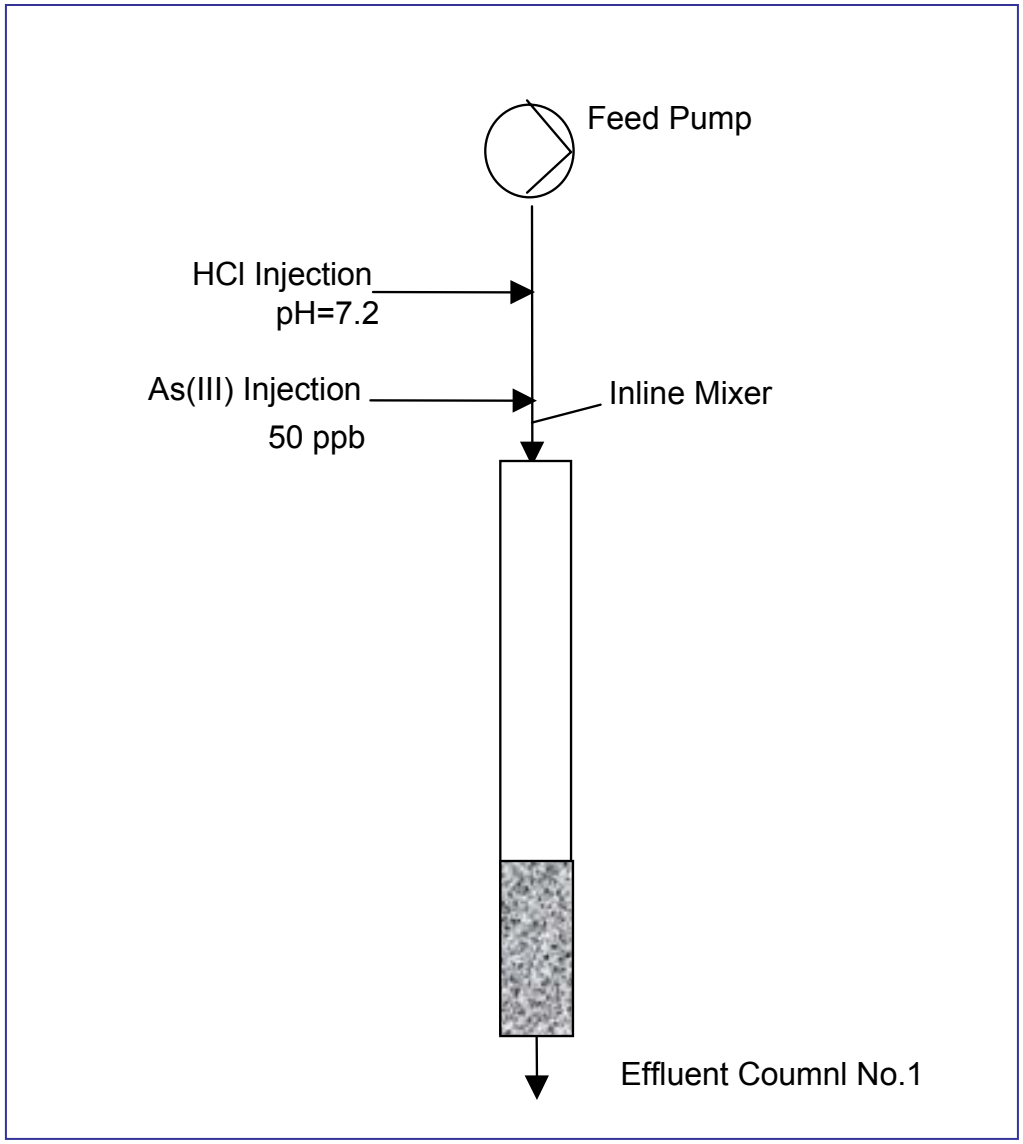
Operational Challenge Test
Pilot-Scale Testing

Pilot-Scale Testing Conditions

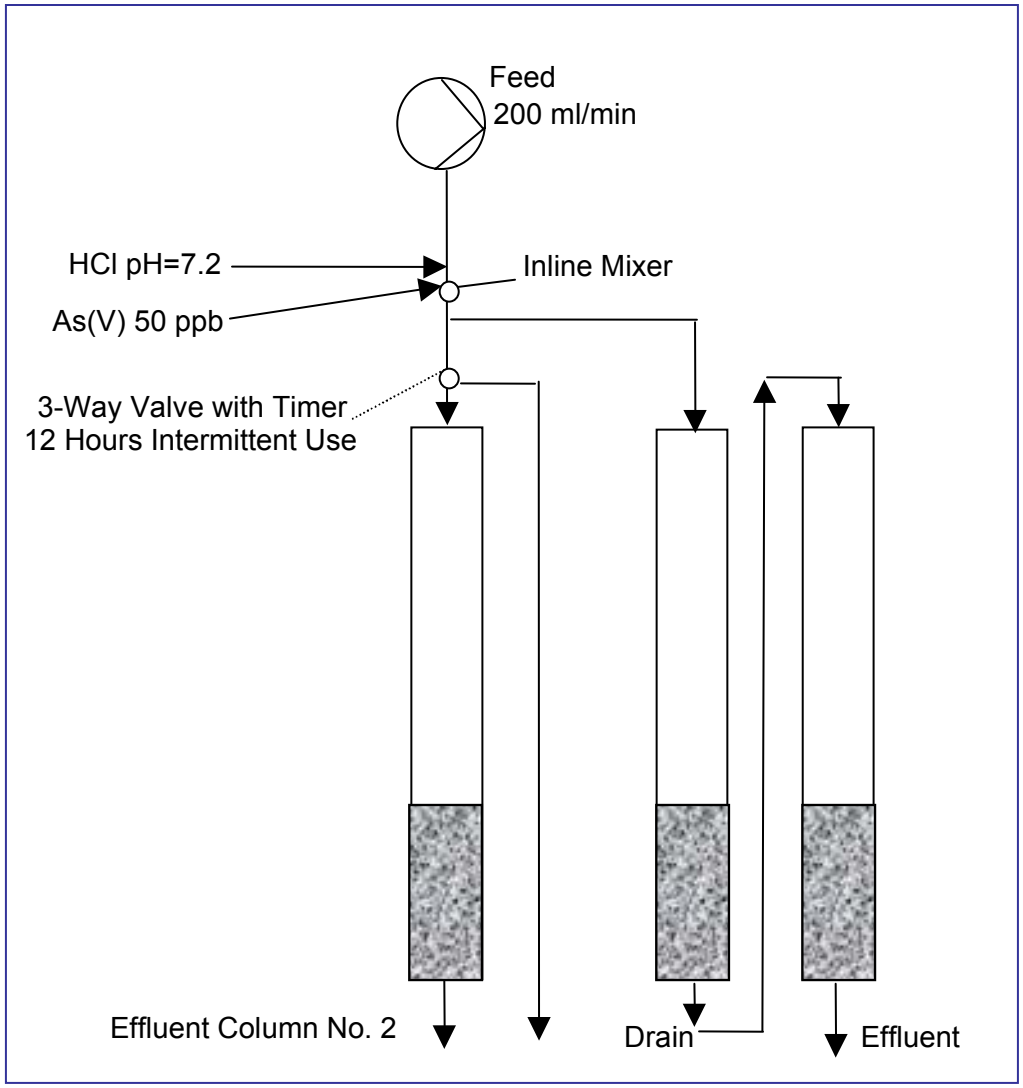
- Investigation of various operational configurations
  - Intermittent operation
  - As(III) vs. As(V) species
  - Lead - lag operation
- pH adjustment: HCl injection
- Arsenic spiking: As(III) or As(V)

Parameters	Conditions
Columns	4
Length	2 m
Diameter	2.5 cm
EBCT	3 minutes
Media height	41 cm
Flow rates	100 ml/minutes

Arsenic(III) Test Column



Arsenic(V) Test Columns



Pilot Testing (Signal Hill)

Summary - Challenge Tests

- Water quality and pH change resulted in arsenic desorption
- Arsenic peaking depend on media type, bed volume, and water quality parameter
- Media with low arsenic breakthrough (<10 ppb) also resulted in arsenic desorption
- Arsenic desorption can occur within a few hours of water quality change

Current/Future Work - Mitigation Strategies

- Lead-lag approach as a dual barrier
- Intermittent operation
- Redundant pH controls in treatment process
- Monitor co-contaminants / potential interferences
- On-line analyzers

Acknowledgement

- AwwaRF/DOE for funding
- AwwaRF PM: Albert Ilges
- AwwaRF PAC: Laurie McNeill, Holly Shorney-Darby, Mark Notheis
- City of Signal Hill - Bob Bostic, Casey Quinn, Mariano Baltazar, David Winn
- Media provider for testing: Engelhard, Purolite, US Filter, Rohm and Haas, Dow Chemicals, Severn Trent, MEI, Resintech.
- Tyler Janks, HMC; Justin Sutherland (Carollo)

Contact Information - jmin@carollo.com

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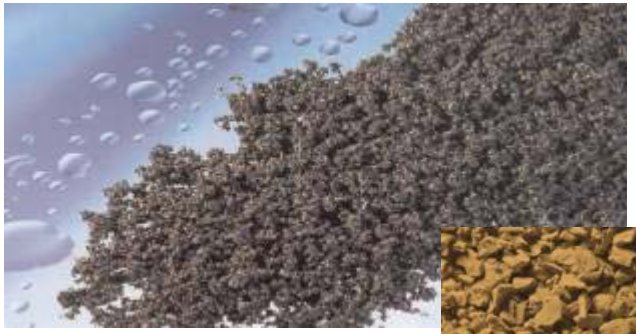
Factors that Affect Arsenic Removal

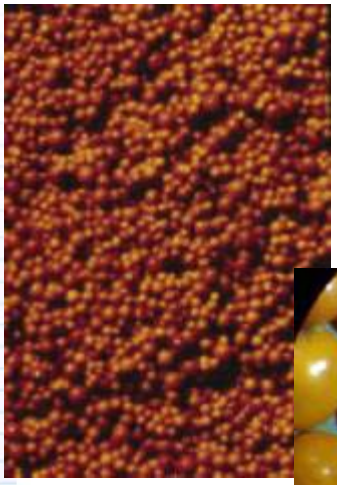
- Constituents that affect treatment process
  - Iron, manganese, calcium, magnesium, barium, TOC, TDS, turbidity, alkalinity, etc.
- Constituents that affect arsenic removal efficiency
  - pH, arsenic speciation (As(III) vs. As(V))

Factors that Affect Arsenic Removal (continued)

- Constituents that compete with arsenic
  - Silica, vanadium, phosphate, fluoride, sulfate, nitrate, molybdenum, chromium, selenium, etc.
- Constituents that affect residual disposal
  - Uranium, gross alpha, gross beta, radium, radon, strontium

Arsenic Adsorption Media





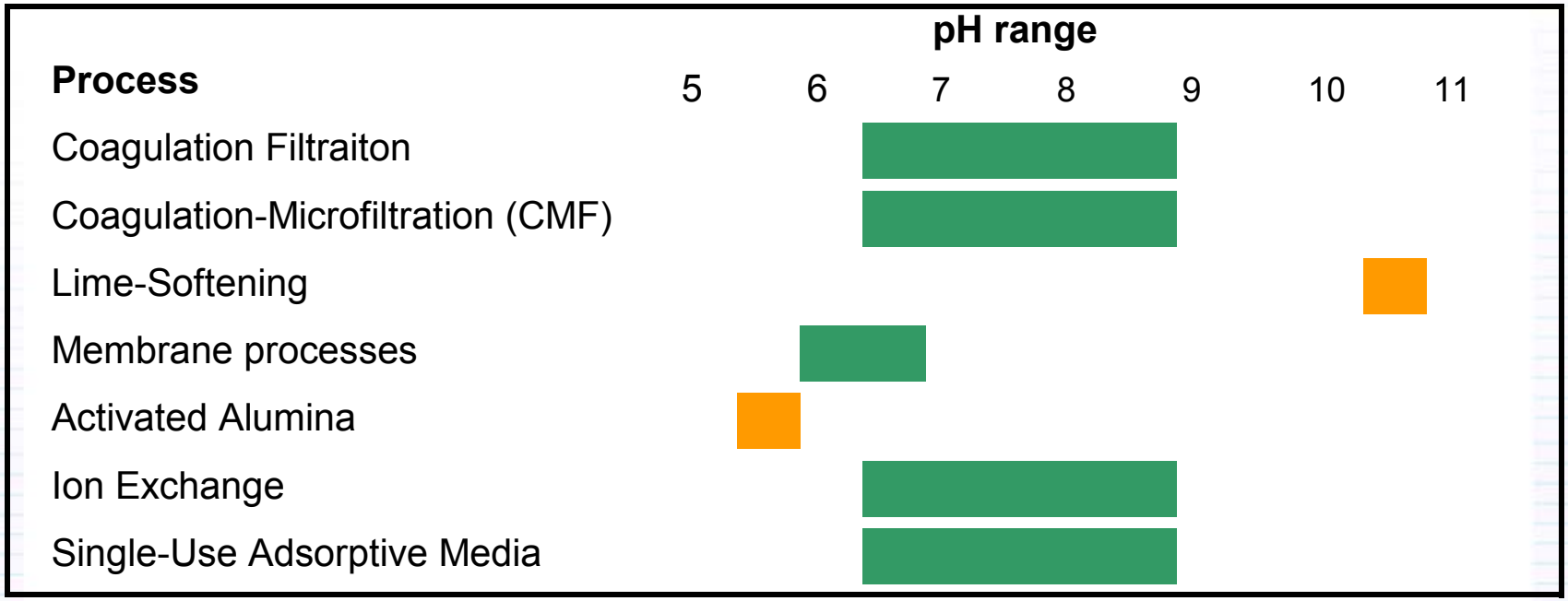
- Granular iron media
- Iron doped resin
- Titanium-based media

Photos from US Filter, Severn Trent, Purolite, Dow Chemical

Arsenic Regulation Status

State	MCL	Note
USEPA and most states	10 ug/L	USEPA MCLG is zero
California	Pending	PHG is set at 0.004 ug/L (4 ppt)
New Jersey	5 ug/L (final)	PHG is set at 0.003 ug/L (3 ppt)

pH Ranges for Arsenic Removal Techniques



Required

Improved performance

Treatment Regime (As and flow)